Jun 5th, 1:30 PM - 1:50 PM

Session B2 - Assessing, Prioritizing, and Implementing Numerous Small Culvert AOP Projects in a Short Period of Time

Roy Schiff
Milone & MacBroom, Inc.

VT116 AOP Culvert Assessment Study

Starksboro and Hinesburg, VT

Roy Schiff and Jessica Louisos
Milone & MacBroom, Inc.

National Conference on Engineering & Ecohydrology for Fish Passage

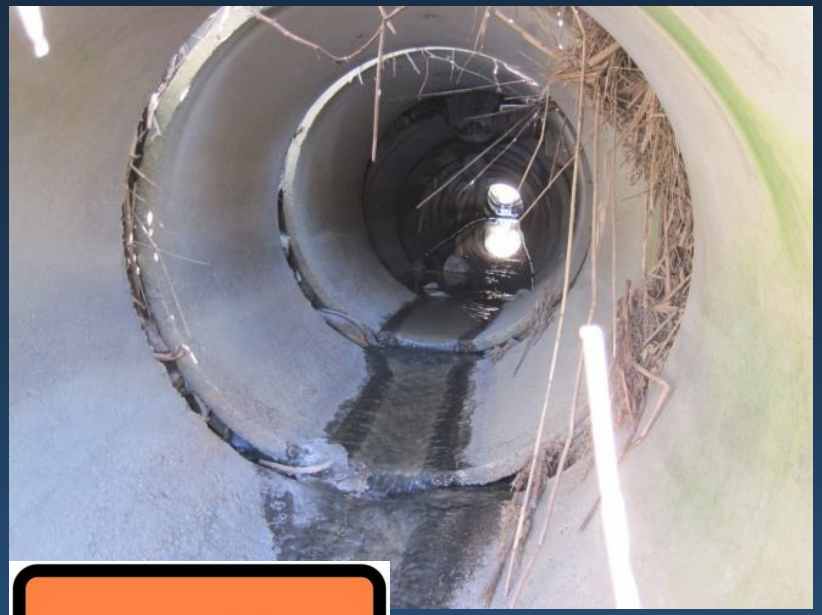
June 5, 2012

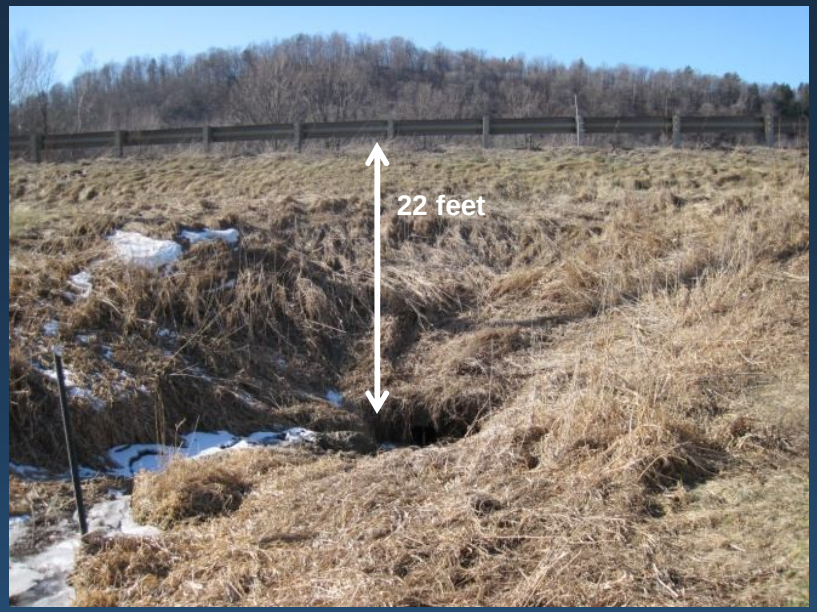
PROJECT PARTNERS
Addison County RPC
Chittenden County RPC
Town of Starksboro
Town of Hinesburg
Lewis Creek Association
LaPlatte Watershed Partnership
Vermont Agency of Transportation
Vermont Fish and Wildlife

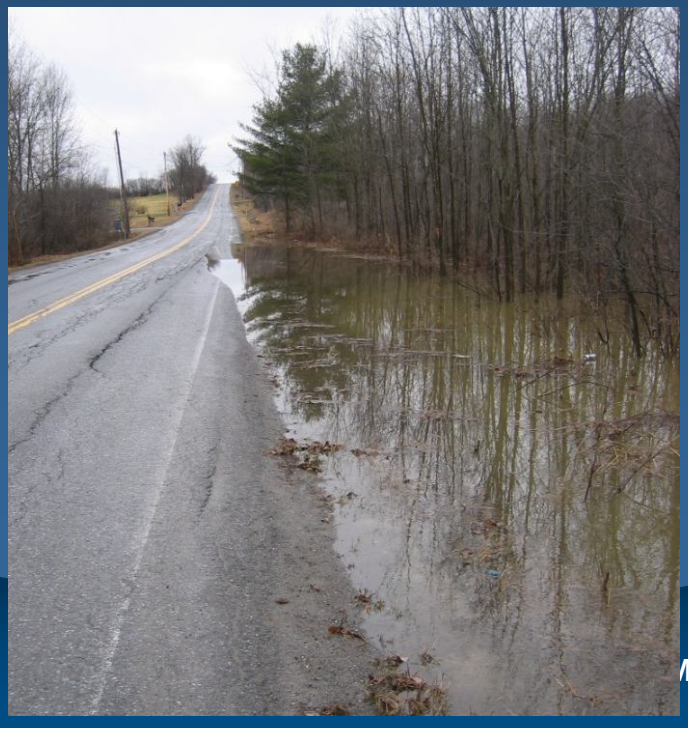
MILONE & MACBROOM®

Pave a Road, Improve Culvert AOP

MILONE & MACBROOM®







FR17A stream crossing over the Jenny Coolidge Brook
$236,300, GMNF, 2012

VT Aquatic Organism Passage Coarse Screen	Full AOP	Reduced AOP	No AOP	
Updated 2/25/2008	**for all aquatic organisms**	**for all aquatic organisms**	**for all aquatic organisms except adult salmonids**	**for all aquatic organisms including adult salmonids**
AOP Function Variables / Values	**Green (if all are true)**	**Gray (if any are true)**	**Orange**	**Red**
Culvert outlet invert type	at grade **OR** backwatered	cascade	free fall **AND**	free fall **AND**
Outlet drop (ft)	= 0		> 0 , < 1 ft **OR**	≥ 1 ft **OR**
Downstream pool present			= yes (= yes **AND**	= no **OR** (= yes **AND**
Downstream pool entrance depth / outlet drop			n/m ≥ 1)	n/a < 1) **OR**
Water depth in culvert at outlet (ft)				< 0.3 ft
Number of culverts at crossing	1	> 1		
Structure opening partially obstructed	= none	≠ none		
Sediment throughout structure	yes	no		

http://www.anr.state.vt.us/dec/waterq/rivers

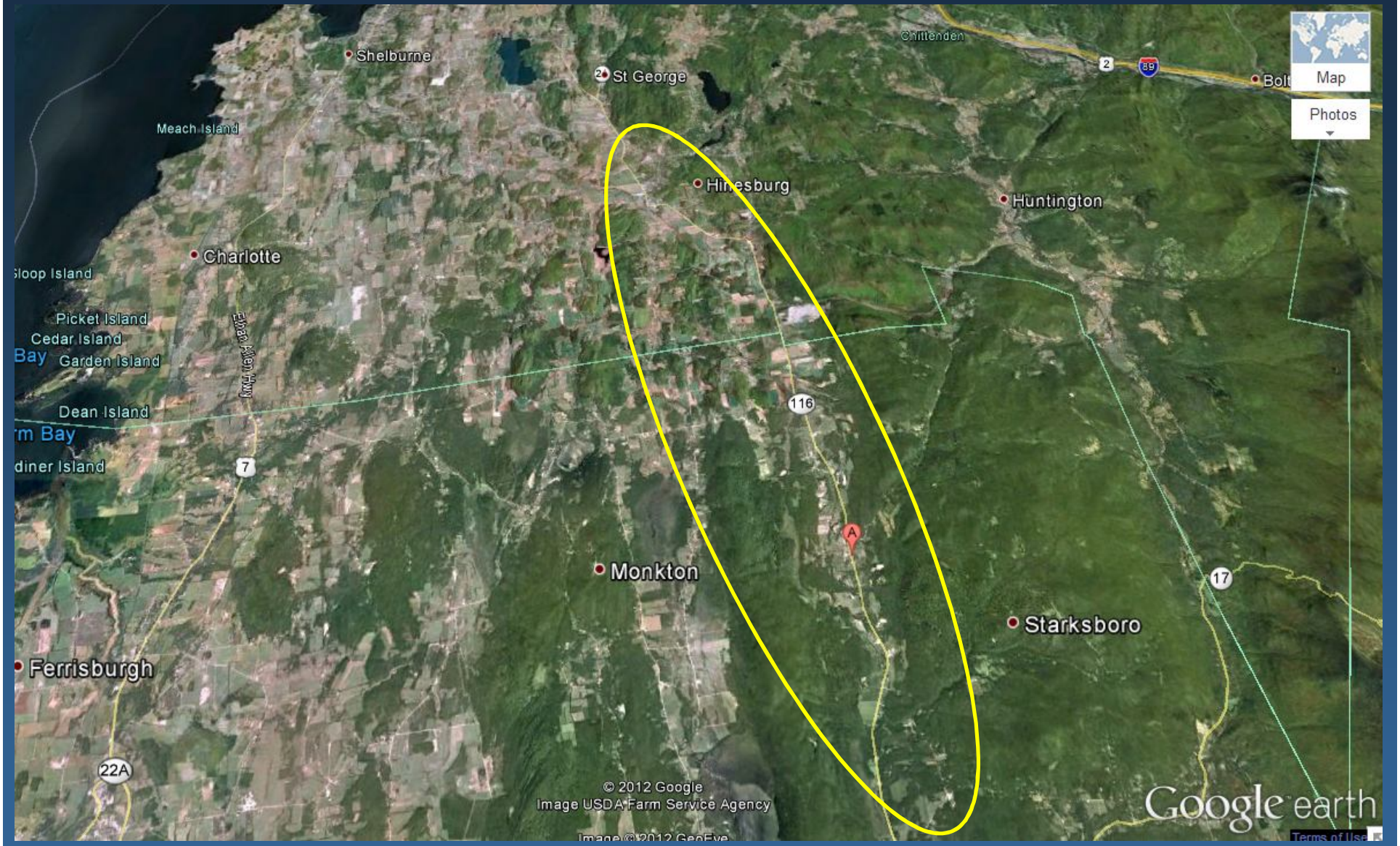
MILONE & MACBROOM®

Category Name	Screen Score	Threshold Conditions	Description of structure-channel geomorphic compatibility
Fully compatible	20<GC≤25	n/a	Structure fully compatible with natural channel form and process. There is a low risk of failure. No replacement anticipated over the lifetime of the structure. A similar structure is recommended when replacement is needed.
Mostly compatible	15<GC≤20	n/a	Structure mostly compatible with current channel form and process. There is a low risk of failure. No replacement anticipated over the lifetime of the structure. Minor design adjustments recommended when replacement is needed to make fully compatible.
Partially compatible	10<GC≤15	n/a	Structure compatible with either current form or process, but not both. Compatibility likely short term. There is a moderate risk of structure failure and replacement may be needed. Re-design suggested to improve geomorphic compatibility.
Mostly incompatible	5<GC≤10	% Bankfull Width + Approach Angle scores ≤ 2	Structure mostly incompatible with current form and process, with a moderate to high risk of structure failure. Re-design and replacement planning should be initiated to improve geomorphic compatibility.
Fully incompatible	0≤GC≤5	% Bankfull Width + Approach Angle scores ≤ 2 **AND** Sediment Continuity + Erosion and Armoring scores ≤ 2	Structure fully incompatible with channel and high risk of failure. Re-design and replacement should be performed as soon as possible to improve geomorphic compatibility.

http://www.anr.state.vt.us/dec/waterq/rivers

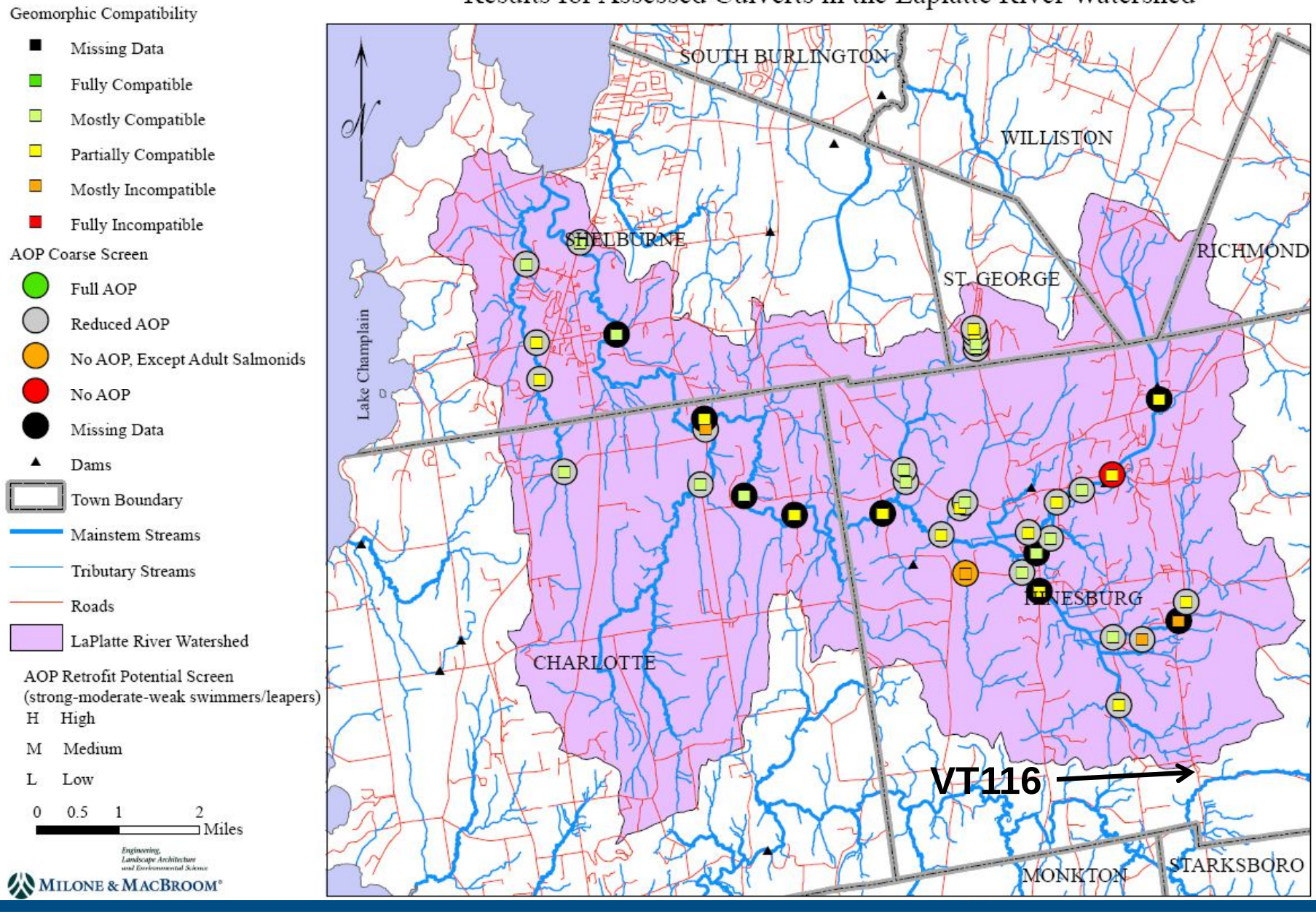
Score	% Bankfull Width	Sediment Continuity	Slope	Approach Angle	Erosion and Armoring
5	%BFW ≥ 120	No upstream deposition or downstream bed scour	Structure slope equal to channel slope, and no break in valley slope	Naturally straight	No erosion **or** armoring
4	100 ≤ %BFW < 120	**Either** upstream deposition **or** downstream bed scour, **without** upstream deposits taller than 0.5 bankfull height **or** high downstream banks	n/a	n/a	No erosion **and** intact armoring, **or** low upstream **or** downstream erosion **without** armoring
3	75 ≤ %BFW < 100	**Either** upstream deposition **or** downstream bed scour, **with** either upstream deposits taller than 0.5 bankfull height **or** high downstream banks	Structure slope equal channel slope, with local break in valley slope	Mild bend	Low upstream **or** downstream erosion **with** armoring
2	50 ≤ %BFW < 75	**Both** upstream deposition **and** downstream bed scour, **without** upstream deposits taller than 0.5 bankfull height **or** high downstream banks	Structure slope higher or lower than channel slope, and no break in valley slope	Channelized straight	Low upstream **and** downstream erosion
1	30 ≤ %BFW < 50	**Both** upstream deposition **and** downstream bed scour, **with** upstream deposits taller than 0.5 bankfull height **or** high downstream banks	n/a	n/a	Severe upstream **or** downstream erosion
0	%BFW < 30	**Both** upstream deposition **and** downstream bed scour, **with** upstream deposits taller than 0.5 bankfull height **and** high downstream banks	Structure slope higher or lower than channel slope, with local break in valley slope	Sharp bend	Severe upstream **and** downstream erosion, **or** failing armoring upstream **or** downstream

http://www.anr.state.vt.us/dec/waterq/rivers

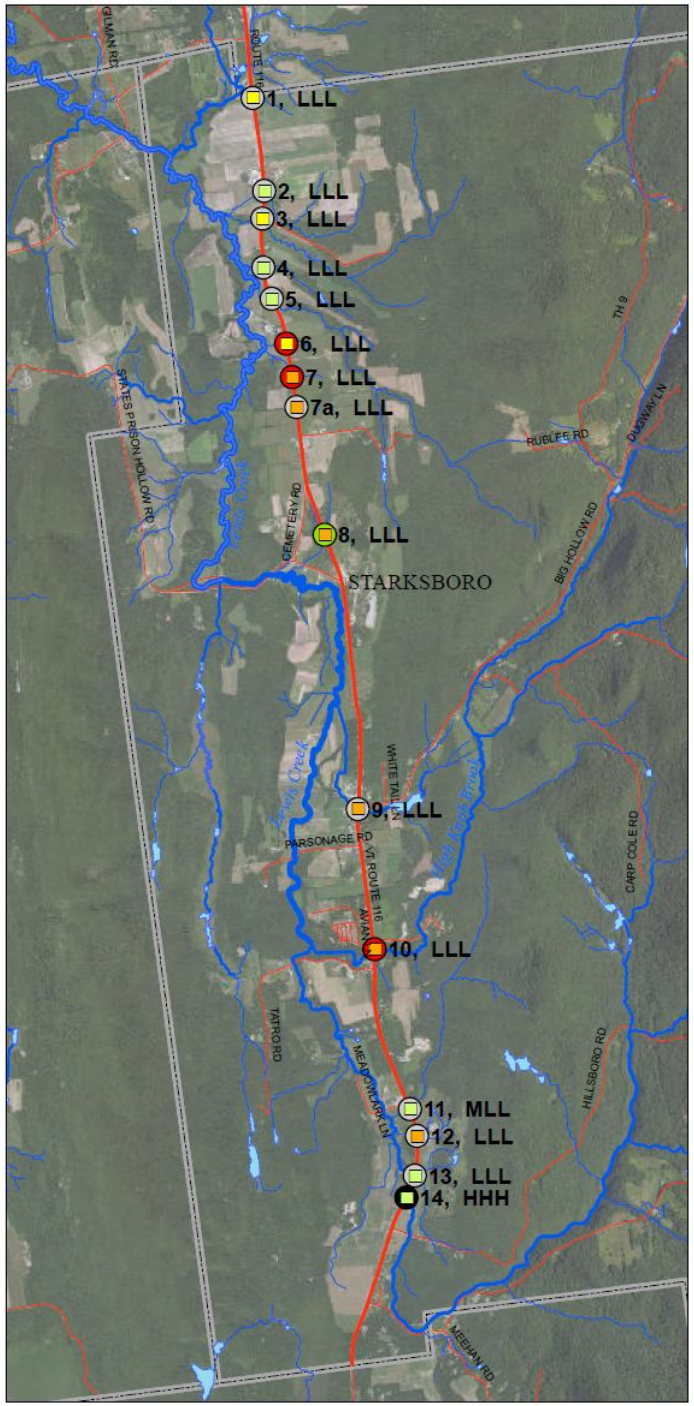


MILONE & MACBROOM®

Vermont Culvert Geomorphic Compatibility Screening Tool and Vermont Aquatic Organism Passage (AOP) Screening Tool Results for Assessed Culverts in the Laplatte River Watershed



Starksboro



Geomorphic Compatibility

- Fully Compatible
- Mostly Compatible
- Partially Compatible
- Mostly Incompatible
- Fully Incompatible
- Bridge

AOP Coarse Screen

- Full AOP
- Reduced AOP
- No AOP, Except Adult Salmonids
- No AOP
- Bridge
- Lakes and Ponds

River (By Stream Order)

1 2 3 4 5

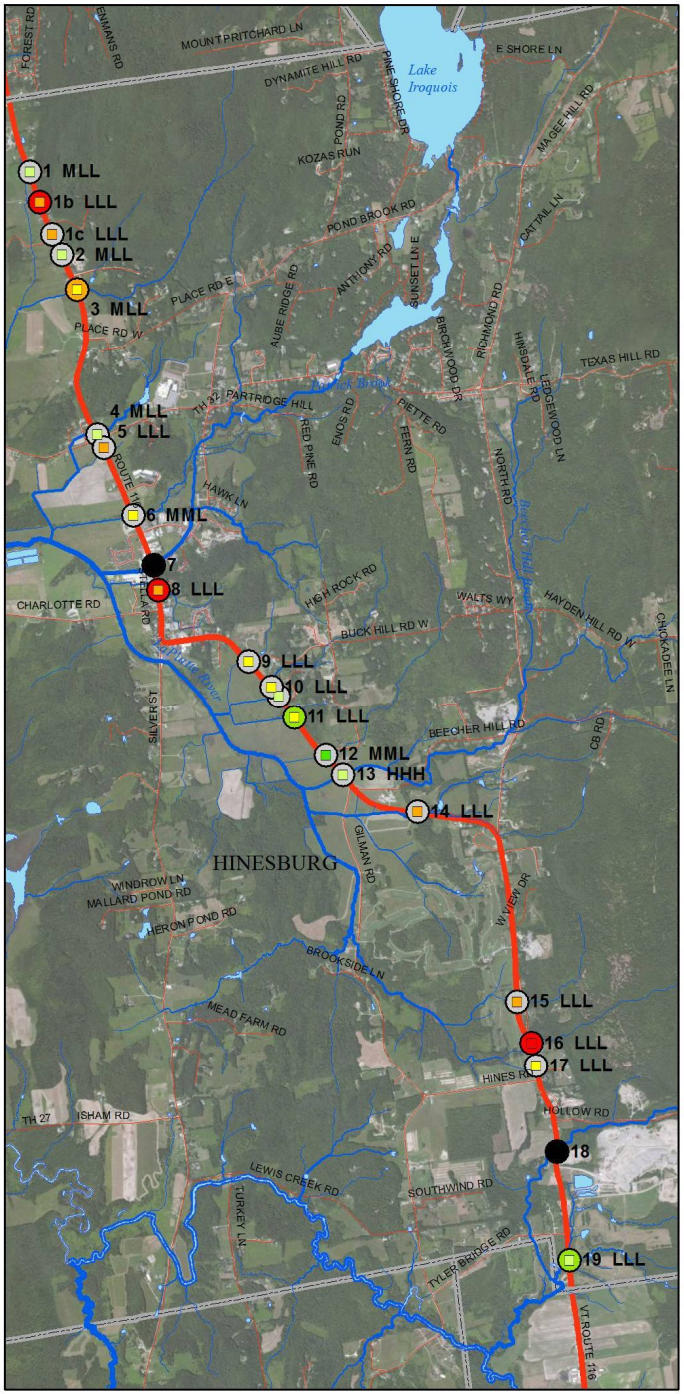
- Town Boundary
- Railroad
- Route 116
- Roads

AOP Retrofit Potential Screen
(strong-moderate-weak swimmers/leapers)

H High
M Medium
L Low

0 0.25 0.5 1 Miles

Engineering, Landscape Architecture and Environmental Science
MILONE & MACBROOM®



Hinesburg

STEP 1: Assessment and Initial Prioritization

LocalID	VTrans Milepost (miles)	Drainage Area (square miles)	Stream Order (Strahler)	Structure Type	Structure Length (ft)	Channel Bankfull Width (ft)*	Structure Width / Channel Width (%)	Culvert Outlet Type	Outlet Drop Height (ft)	Fill over Upstream end of Pipe (feet)	AOP Coarse Screen	Retrofit Potential	GC SCREEN
1	6.86	0.0	0	24" round RCP	40	*3*	40	At Grade	0	4	GRAY	MLL	LEMON LIME
3	6.24	0.9	2	42" round CMP	50	10	35	Free Fall	0.9	7	ORANGE	MLL	YELLOW
6	5.05	7.4	2	7' x 4' concrete box	30	10	70	Entirely Backwatered	0	3	GRAY	MML	YELLOW
14	2.73	0.7	3	48" round RCP	75	*11*	25	Cascade	1	3	GRAY	LLL	ORANGE

LocalID	AOP / Habitat Notes	Structure Condition Notes	AOP Priority #	Structural Priority #	GC Priority #	Constructability	Meeting Notes	50-Year Design Flow (cfs)	Method
1	Limited fish habitat. Road ditch upstream	Good condition.	19	20	18	High		44	BPR Method
3	Good habitat potential. Downstream channel needs buffer. Upstream in wooded corridor.	Moderate condition. Some sagging in roof, erosion on embankment.	2	11	6	High		167	Average
6	Patrick Brook. Good habitat potential. Wooded buffer, large drainage area.	Moderate Condition. Floor and lower seams scoured and cracked. Otherwise ok condition.	4	6	11	Low. Expensive concrete structure.	Hold off on this structure. Possible road widening associated with work at Commerse Street.	689	Average
14	Good habitat potential. Upstream needs buffer. Other smaller pipe downstream.	Moderate condition. Embankment eroding. Sink hole at road edge at upstream end.	3	9	2	High	Vtrans to reset or replace. Downstream structure at Gilman Road OK. Talk with landowner about downstream farm crossing.	159	Average

STEP 2: Hydraulic and AOP Calculations and Final Prioritization

LocalID	Existing Structure Type	Conveyance Design Type	Conveyance Design Size (in)	Conveyance Design Fish Passage Percent	Conveyance Design Low Flow AOP Barrier Type	Conveyance Design High Flow AOP Barrier Type	AOP Improvement Notes	Improved Type	Improved Size (in)	Improved Passage Percent	Improved Low Flow AOP Barrier Types	Improved High Flow AOP Barrier Types
1	24" round RCP	CPP	36	AOP not applicable. Limited habitat potential.								
3	42" round CMP	CMP	66	0	Depth, Outlet Drop	Outlet Drop, Velocity	Increase pipe size from 66" to 72". Embed 1 foot. Lower inlet 1.75', lower outlet 1.5', and decrease slope by 0.5% to eliminate outlet drop	CMP	72	100	None	None
6	7' x 4' concrete box	Box	14' x 7'	0	Depth	Depth, Velocity	Increase height by 1'. Embed 1'. Lower elevation 1.' and reduce slope by 0.9% to 2.0% to reduce velocity and increase depth of flow.	Box	14' x 7'	100	None	None
14	48" round RCP	CMP	66	0	Depth, Drop	Drop, Velocity	Increase pipe size from 66" to 72". Embed 1'. Lower inlet elevation by 0.6', lower outlet by 1', increase slope by 0.6% to 3.6% to eliminate drop and decrease length of depth barrier. Downstream culvert needs to be addressed also.	CMP	72	0	Depth	Depth, Velocity

LocalID	AOP Design Type	Changes to Inlet and Outlet Elevations*	Changes to Structure Slope	Alignment	AOP Design Percent Fish Passage	AOP Design Low Flow Barrier Type	AOP High Flow Barrier Type	AOP Priority #
1								19
3	10.7' x 6.9' Pipe Arch	Lower inlet 1.25' to reduce slope and lower outet 1.5' to eliminate drop. Modify farm ford downstream to increase elevation by 0.5' to increase backwater.	Increase slope by 0.5% (PR = 1.5%, EX = 1.0%, US = 1.0%) to eliminate drop.	No Change. Naturally Straight.	100	None	None	2
6	14' x 8' Box	Lower inlet by 1.5' to reduce slope. Lower outlet by 1.0' to increase backwater depth.	Decrease slope by 0.9% (PR = 2%, EX = 2.9%, US = 1.7%) to reduce velocities.	No Change. Mild Bend.	100	None	None	4
14	11.4' x 7.3' Pipe Arch	Lower inlet by 0.5' to reduce slope and outlet by 1.0' to eliminate drop.	Increase slope by 0.6% (PR = 3.6%, EX = 3.0%, US = 3.6%) to eliminate drop.	Skewed. Sharp Bend. Channelized along road, difficult to improve alignment.	no calc	Depth	Depth, Velocity	3

STEP 3: Design Recommendations

I II III

LocalID	VTrans Milepost (miles)	Drainage Area (square miles)	Existing Structure Type	Channel Bankfull Width (ft)*	VTrans Plan of Action Due to Condition**	Upgrade for Flow Capacity	Upgrade for AOP Improvement	Upgrade for Full AOP and Geomorphic Compatibility	Design Recommendation	AOP Priority #
Action Items During VTrans Paving Project (Listed by Priority.)										
3	6.2	0.9	42" CMP	10	Field Visit	66" CMP	72" CMP	10.7' x 6.9' Pipe Arch	Lower inlet 1.25' to reduce slope and lower outlet 1.5' to eliminate drop. Increase slope by 0.5% to 1.5%. Modify farm ford downstream to increase elevation by 0.5' to increase backwater. Embed 20%	2
14	2.7	0.7	48" RCP	*11*	Field Visit	66" CMP	72" CMP	11.4' x 7.3' Pipe Arch	Increase pipe size from 66" to 72". Embed 1'. Lower inlet elevation by 0.6', lower outlet by 1', increase slope by 0.6% to 3.6% to eliminate drop and decrease length of depth barrier. Downstream culvert needs to be addressed also.	3
19	0.2	0.8	42" RCP	13	Field Visit	72" CMP	72" CMP	13' x 7' Box	Install as existing.	5
10	3.7	0.3	36" RCP	*7*	Field Visit	54" CMP	54" CMP	7.3' x 5.3' Pipe Arch	Embed pipe 1 foot. Lower elevation by 1.0'. Decrease slope by 0.8% to 1.5%.	8
4	5.5	0.3	4' x 2.5' Box	10	Field Visit	54" CMP	54" CMP	10.7' x 6.9' Pipe Arch	Install as existing.	10
Future AOP Recommendations (Listed by Priority.)										
16	1.3	0.5	35" CMP	*10*	No Change	60" CMP	60" CMP	10.3' x 6.8' Pipe Arch	Lower inlet by 3.71' and outlet by 2' to eliminate drop. Modify downstream riffle to increase backwater by 1.0'. Decrease slope by 1.8% to 1.5%. Embed 20%. (To be investigated by US F&W. Possibly move to Action List.)	1
6	5.1	7.4	7' x 4' Box	10	No Change	14' x 7' Box	14' x 7' Box	14' x 8' Box	Lower inlet by 1.5' to reduce slope. Lower outlet by 1.0' to increase backwater depth. Decrease slope by 0.9% to 2%. Embed 20%.	4
1b	6.7	0.2	4.3' x 3.2' Box	*7*	No Change	No	48" CMP	7.3' x 5.3' Pipe Arch	Replace with 48" CMP. Embed 0.5'. Lower elevation 4 feet to eliminate drop.	7
13	3.2	3.2	Two 10' x 6.5' Pipe Arches	*22*	No Change	No	*Beyond Scope of Project.*	*N/A*	Replace with single span structure at least 100% bankfull width. Likely a bridge structure. (Beecher Hill Brook).	6
12	3.3	0.3	60" CMP	10	No Change	No	No	10.7' x 6.9' Pipe Arch	Embed 1 foot. Lower elevation by 0.5'.	9
AOP Not Applicable. Limited Habitat Potential.										
1	6.9	0.0	24" RCP	*3*	Clean	36" CPP	*AOP not applicable. Limited habitat potential.*		Clean sediment out of ends.	19
1c	6.5	0.1	24" CMP	*5*	Field Visit	36" CPP	*AOP not applicable. Limited habitat potential.*		*N/A*	14
2	6.4	0.0	30" CMP	*3*	Clean	No	*AOP not applicable. Limited habitat potential.*		Remove sediment from pipe to restore capacity.	17
5	5.4	0.0	18" RCP	*3*	Field Visit	30" CPP	*AOP not applicable. Limited habitat potential.*		*N/A*	18
8	4.7	0.1	36" CMP	*5*	No Change	60" CMP	*AOP not applicable. Limited habitat potential.*		Increase pipe size from 60" to 66". Embed 1'. Lower inlet 2.3', lower outlet 2.6', and increase slope by 0.3% to 1.5% to decrease velocity and increase depth. Increased tailwater elevation 1.5'.	12
9	3.9	0.1	36" RCP	*5*	Field Visit	6.4' x 4.3' Pipe Arch	*AOP not applicable. Limited habitat potential.*		Limited fill depth, required pipe arch. 72" pipe satisfied conveyance criteria.	13
10b	3.7	0.0	18" RCP	*1*	No Change	No	*AOP not applicable. Limited habitat potential.*		*N/A*	20
11	3.5	0.1	18" RCP	*4*	No Change	30" CPP	*AOP not applicable. Limited habitat potential.*		*N/A*	16
15	1.5	0.2	36" RCP	*6*	No Change	42" CMP	*AOP not applicable. Limited habitat potential.*		Increase pipe size by 1' to 54". Lowered inlet by 2.6' and outlet by 2.4'. Decrease slope from 7% to 5.8%. Increase slope of channel upstream by 2%. Increase tailwater downstream by 1'.	11
17	1.1	0.1	18" RCP	*4*	Repair	36" CMP	*AOP not applicable. Limited habitat potential.*		Fix Headwall.	15
Bridges. No AOP problems.										
7	4.8	7.2	Bridge	21	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	22
18	0.7	7.5	Bridge	34	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	21

H3

H14

H6

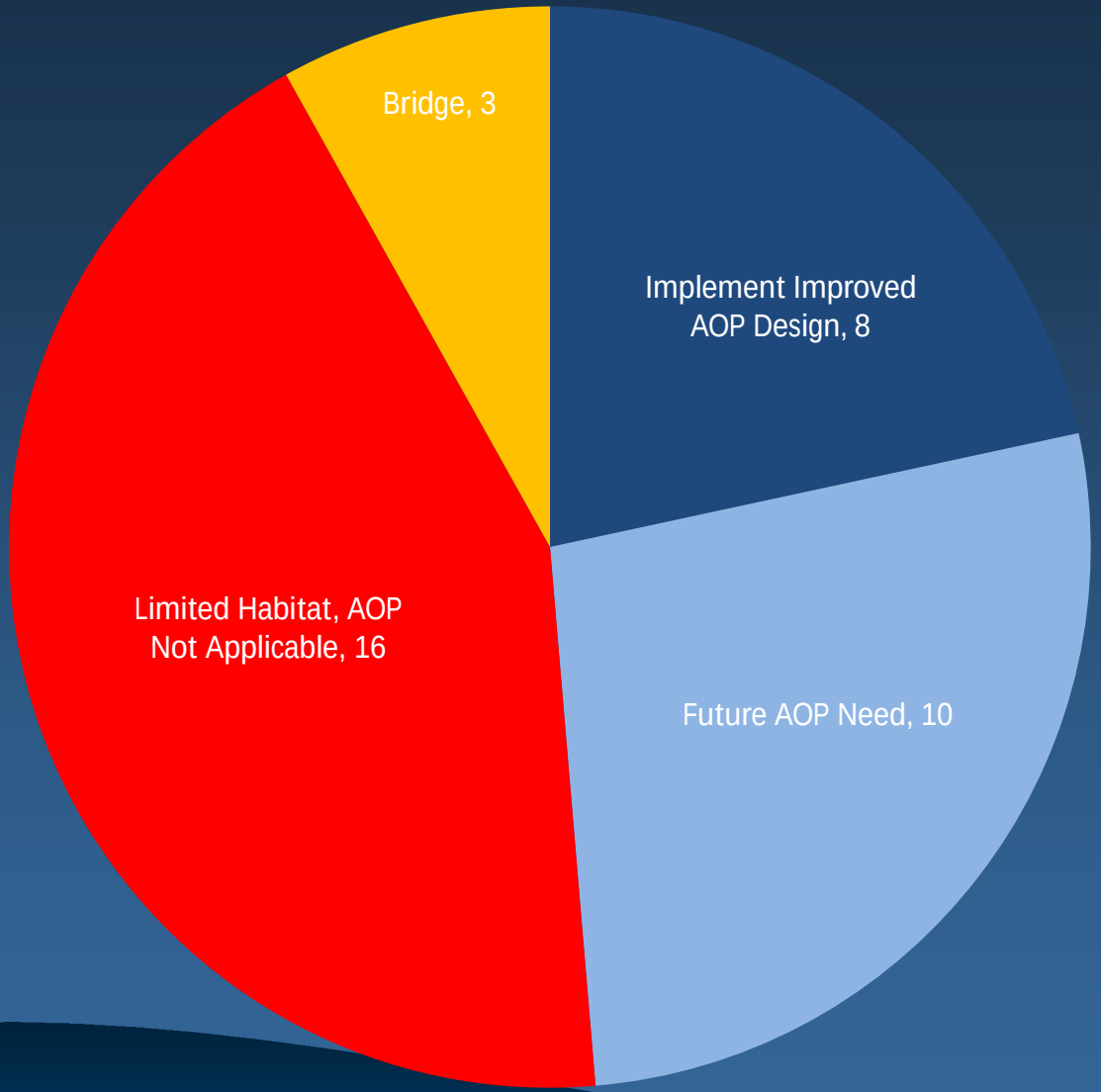
H1

Project Summary

14 miles of roadway

37 culverts

$25,000



MILONE & MACBROOM®